

## THE POST-REINFORCEMENT PAUSE<sup>1</sup>

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Measurements of the post-reinforcement pause and response rate were obtained from four birds on a range of fixed ratio schedules from 25 to 150. The results indicated a consistent increase in the length of the pause as the ratio was increased. Response rate tended to decrease, but these data were less consistent and some reversals were apparent.

A fixed ratio schedule of reinforcement generates a behavior pattern which is typically bimodal (Ferster and Skinner, 1957). The response rate is either at a high terminal rate or at zero. The most regular period of zero responding usually occurs immediately after a reinforcement is presented and is defined as the "post-reinforcement pause". It is commonly accepted that the post-reinforcement pause increases, and response rate tends to decrease slightly as the ratio requirement is increased. This conclusion is based largely on the cumulative records presented by Ferster and Skinner (1957) and individual observation of behavior on this schedule.

A number of other studies (Premack, Schaeffer, and Hundt, 1964; Thompson, 1964; Winograd, 1965; Kaplan, 1956) also indicate a positive relationship between the pause length and the fixed ratio demand, although these data were not obtained under typical appetitive reinforcement conditions. Premack *et al.* recorded the number of licking responses on schedules ranging from FR 10 to FR 500 when wheel running was presented as the contingent event. Thompson's data were recorded during escape from a stimulus associated with various fixed ratio schedules. The results of the other two studies were obtained on fixed ratio escape schedules with

shock (Winograd, 1965) and bright light (Kaplan, 1956) as the aversive stimulus.

The properties of the response rate as a function of the fixed ratio schedule remain uncertain. The data presented by Winograd (1965) suggests a decrease in the response rate as the ratio increased, although no simple function common to all subjects was apparent. The data presented by Kaplan (1956) involving escape behavior, Premack *et al.* (1964), using the licking response as the dependent variable, and Boren (1961) under conditions of nutritive reinforcement with ratios ranging from FR 1 to FR 20 all indicate a positive relationship between the rate of response and the fixed ratio demand over a moderate range of FR values. This demonstration that ratio requirement affects terminal response rate is rather surprising in view of the fact that a number of other investigators have found the response rate on a fixed ratio schedule to be insensitive to the manipulation of other experimental variables including punishment (Azrin, 1959), food deprivation (Sidman and Stebbins, 1954), and conditioned suppression (Lyon, 1964).

The present study was designed to extend the analysis of fixed ratio schedules and to obtain quantitative time data of the post-reinforcement pause and the response rate as a function of the fixed ratio requirement.

### METHOD

#### *Subjects*

Four experimentally naive White Carneaux barren hen pigeons were maintained within 15 g of 75% of their free feeding weight. The deprivation rhythm was maintained by feeding

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maple peas when necessary. Water was available at all times.

### Apparatus

A 13 by 13 by 15½ in. response chamber was constructed in a sound attenuated enclosure (Gill, Fry, and Kelleher, 1962) fitted with a 50 cfm exhaust fan to provide ventilation. The response key was a .75 in. back-lighted translucent disk mounted 8 in. from the floor in the center of the wall. The key required approximately 6-8 g pressure to operate. On the same wall 2½ in. above the floor was a 2 by 2½ in. opening through which a grain hopper containing 50% Kaffir, 40% Vetch and 10% Hempseed could be made available. Reinforcement was a 3½-sec presentation of this hopper. During reinforcement a dim light was presented above the reinforcement hopper and the two 6 w house lights were extinguished. House lights were mounted 10 in. from the floor and 2 in. from the side walls.

The fixed ratio schedule was programmed by a pre-determining counter and appropriate relay circuitry. The data were recorded from electrical impulse counters and a Gerbrands recorder. The elapsed time from the end of the reinforcement to the first response in the ratio run, *i.e.*, the post-reinforcement pause, was measured in tenths of a second by a running time meter.

### Procedure

Key pecking behavior was first established on continuous reinforcement. Number of responses required for reinforcement was then gradually increased to FR 50. After behavior was stable, the FR schedule was increased in successive steps up to 150 for all birds and allowed to stabilize at each value, followed by a redetermination of the effect of the FR 50. The sequence and total number of sessions at each ratio requirement are presented in Table 1 for the four birds. The length of the post-reinforcement pause was recorded at FR 75 for birds 272 and 226, since the initial change from FR 50 to FR 100 severely disrupted behavior in terms of extremely long pauses. A recording of the post-reinforcement pause at FR 25 was included for bird 272 since the data at FR 150 are not extensive. Each session was terminated after the bird accumulated 50 reinforcements.

Table 1

Pigeon number	Number of sessions and schedule					
	FR 50	FR 75	FR 100	FR 150	FR 25	FR 50
272	29	17	12	8	16	7
282	22		26	25		9
226	20	15	12	11		8
290	19		25	20		10

## RESULTS

The results were first analyzed in terms of the cumulative post-reinforcement pause in seconds for each session. The mean post-reinforcement pause for the last five sessions for each of the FR schedules are presented in Fig. 1 for the four birds as a function of the FR requirement. The curve describing this function shows an increase in the pause for all birds as the FR requirement was increased. Note that the ordinate is plotted in logarithmic units, which tends to decrease the slope of the curves. The points directly in front of the FR 50 axis represent the initial and the redetermined values for the FR 50. The curve passes through the mean value of these two points. Except for bird 226, the initial and redetermined points approximate one another very closely.

The mean rate of response per second was computed by dividing the total number of responses per session by the total session time less the post-reinforcement pause. The mean rate of response for the last five sessions of each FR schedule are presented in Fig. 2 for the four birds as a function of the FR requirement. The functional relationship indicates a trend toward a decrease in the rate as the

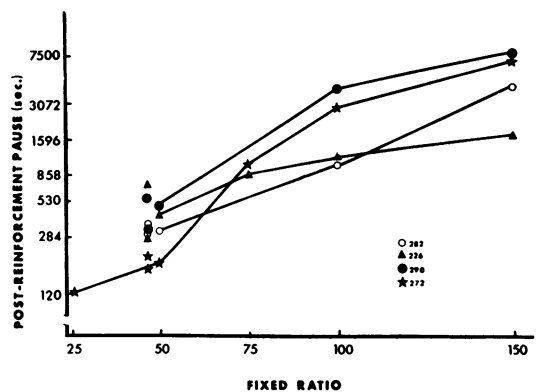


Fig. 1. The mean cumulative post-reinforcement pause in seconds for the last five sessions of each fixed ratio requirement.

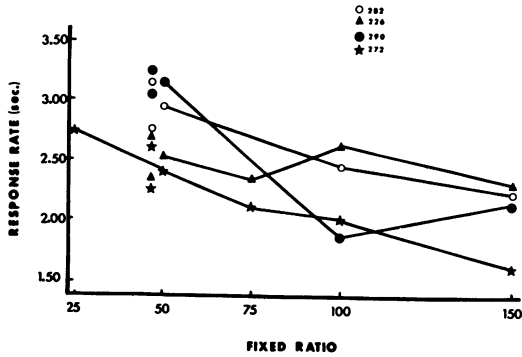


Fig. 2. The mean response rate per second for the last five sessions of each fixed ratio requirement.

ratio was increased to 150. These data are not consistent, since a number of reversals are apparent.

Typical cumulative records for one bird (#282) are presented in Fig. 3. These data clearly indicate an increase in the post-reinforcement pause as the ratio requirement was increased. The slope of the cumulative records indicates that the terminal rate on all schedules was quite similar and consistent. These data suggest that the major change in the response rate does not occur in the local rate of response during the run, but is the result of increased multiple pauses as the ratio was increased. Three of the general multiple pause patterns are indicated by the arrows.

## DISCUSSION

Ferster and Skinner (1957) suggest that the post-reinforcement pause increases and response rate tends to decrease as the fixed ratio schedule is increased. The present results clearly confirm the first portion of this suggestion: consistent and stable increases in the post-reinforcement pause were obtained for all birds. The response rate data indicates a general decrease in rate, but it is neither consistent nor stable. In addition, the decrease in response rate does not represent absolute changes in the local rate during the ratio but is in part due to the multiple pauses at the higher ratios, in accord with other findings (Ferster and Skinner, 1957; Winograd, 1965; Kaplan, 1956). Unfortunately, this interpretation is based solely upon inspection of the cumulative records, since no other quantitative data were available.

In general, the results of the present study support the apparent consensus that response rate and the post-reinforcement pause for fixed ratio schedules be treated as two separate dependent variables.

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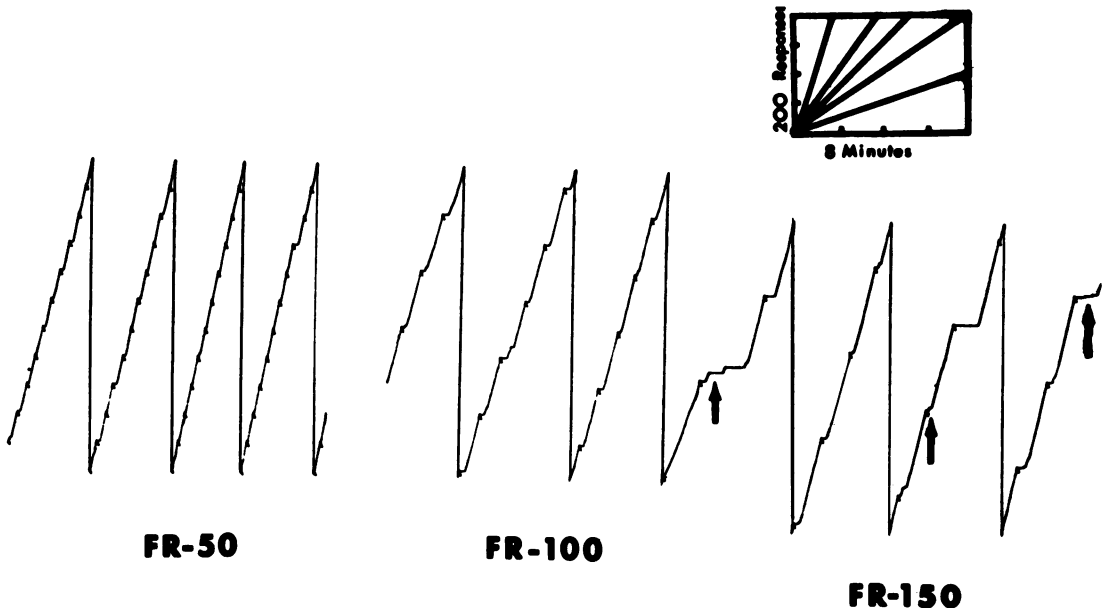


Fig. 3. Typical cumulative records for pigeon 282.

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